(12) UK Patent Application (19) GB (11) 2 113 044 A

(21) Application No 8136509
(22) Date of filing 3 Dec 1981
(43) Application published 27 Jul 1983
(51) INT CL³ H04M 19/02
(52) Domestic classification H4K BL BT
(56) Documents cited None
(58) Field of search H4K
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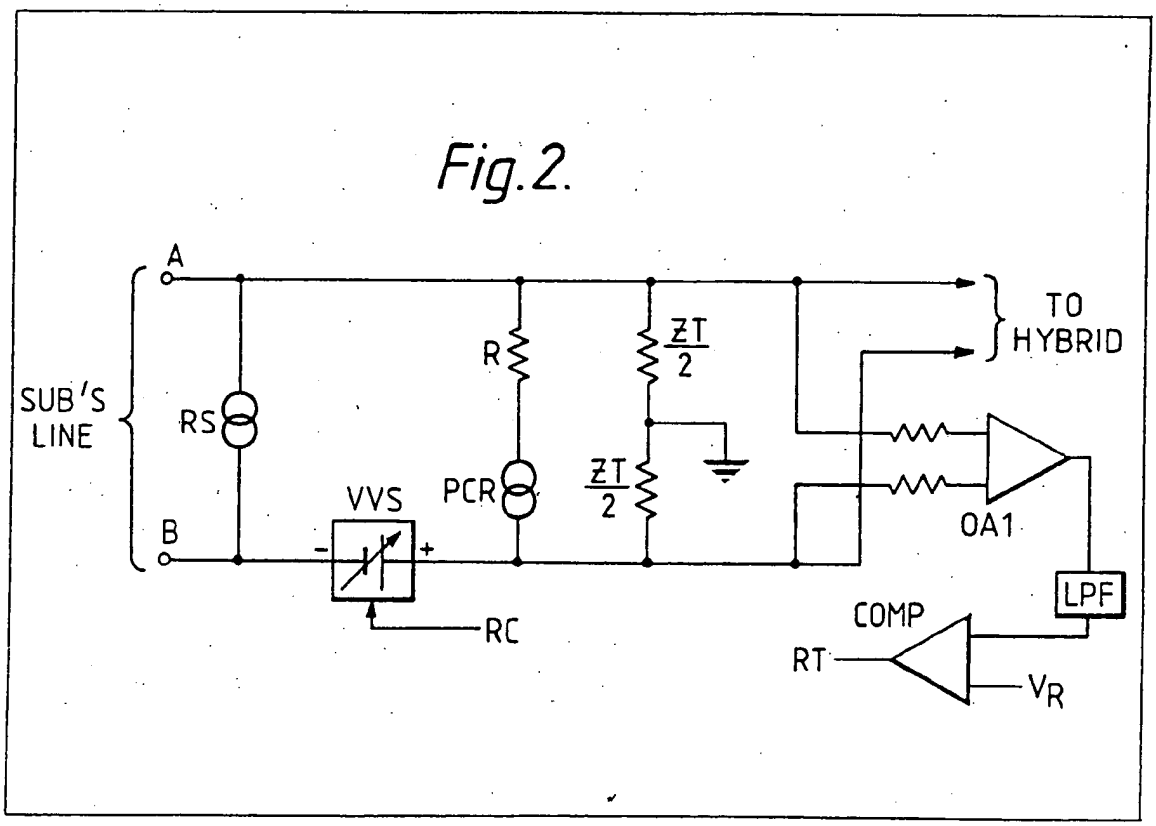
(54) **Telephone ringing signal generation**

(57) In our Application No. 8005000 (GB 2071461A) we have described a telephone line circuit which includes a programmable (i.e. adjustable) voltage source (VVS) connected in series with the line in one wire (B) thereof, and also a constant-current source (PCR) connected between the two line wires. Line conditions are monitored, and the line supply as defined by these two sources is so controlled in accordance with line conditions as to minimise power dissipation. Thus for a short loop, voltage can be reduced.

The present invention relates to the supply of ringing current in such a circuit. The ringing current is applied from a low-level supply to the variable voltage source (VVS), so that it is amplified and modulates the DC line feed. In addition there is a further controlled current device (RS) on the line side of the voltage source (VVS) which is enabled when ringing current is present. This device by virtue of the current it diverts during ringing regulates the AC ringing current level as applied to the line.



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

Fig.1.

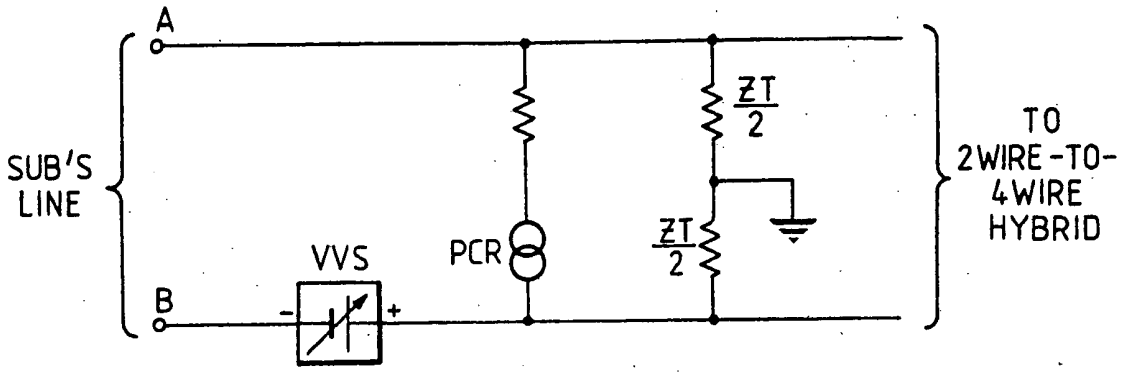

A
B
SUB'S LINE
VVS
PCR
ZT/2
ZT/2
TO 2WIRE-TO-4WIRE HYBRID

Fig.2.

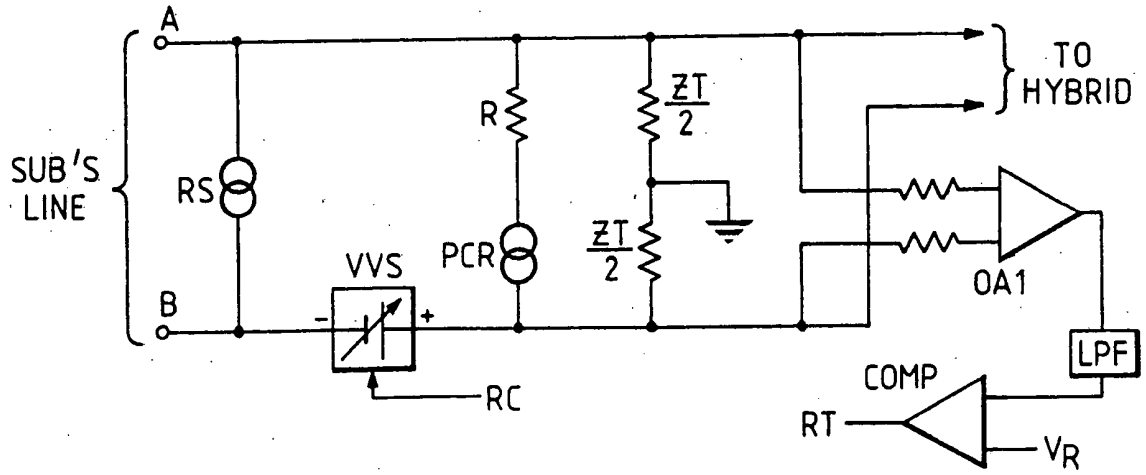
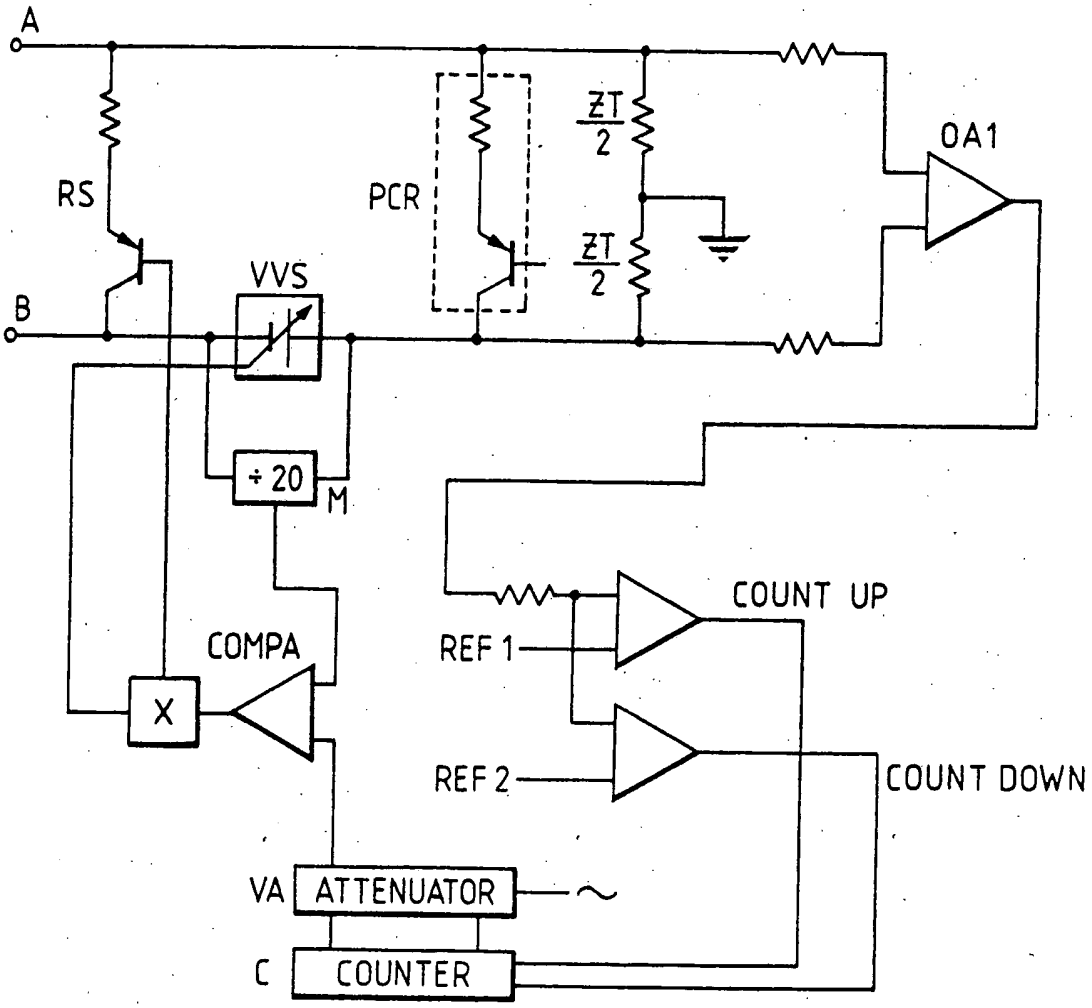

A
B
SUB'S LINE
RS
VVS
PCR
R
ZT/2
ZT/2
RC
TO HYBRID
OA1
LPF
COMP
RT
VR

Fig.3.


A
B
RS
PCR
ZT/2
ZT/2
OA1
VVS
÷ 20
M
COMPA
X
COUNT UP
REF 1
REF 2
COUNT DOWN
VA
ATTENUATOR
C
COUNTER

SPECIFICATION

Telephone ringing signal generation

This invention relates to a telephone subscriber's line circuit, which is often now referred to as a line interface.

In our Patent Specification No. 8005000 (A.W. Sweet et al 20—5) we have described and claimed an arrangement for providing the direct current line supply for a telephone line circuit, and an example of such an arrangement as described in the above specification will now be briefly described with reference to the accompanying Fig. 1.

In Fig. 1, a variable voltage source (VVS) is connected in series with the line impedance termination ZT, which is centre-tapped to earth. This source is itself powered from the exchange supply, and supplies the DC power for the line, and its output voltage is controlled in accordance with line conditions, and it has a low impedance to speech. During the speaking phase of the line circuit operations, there is a potential of approximately 4 volts DC across the line termination, so that the A wire is at —2 volts and the B wire (on the line side of the voltage source) is normally between —10 and —60 volts to earth. The exact potential on the B wire depends on the output of VVS which is itself controlled in accordance with the subscriber line loop conditions, as described in the above-mentioned specification.

Also connected across the line, and in parallel with the termination impedance ZT is a programmable (which in this context means adjustable) current regulator PCR, which is a constant current device set to deliver the current needed by the particular subscriber loop, in accordance with either a constant current feed law or a constant voltage feed law. The operation of PCR, as well as that of VVS, is controlled in accordance with line conditions, which is effected as described in the above specification, by monitoring line conditions and making suitable compensating adjustments to PCR and/or VVS.

An object of the invention is to provide for the supply of ringing current to the line.

According to the invention there is provided a telephone subscriber's line circuit, which includes a terminating impedance connected between the two wires of the line, which impedance has a centre-tap which is earthed, a variable voltage source supplied by the exchange power supply and whose output provides the direct current voltage drive for the line control means which monitors the direct voltage between the line wires and to so control the voltage source that the voltage supplied therefrom is controlled in accordance with line conditions, such that variations in line conditions cause compensatory variations in the line voltage supply, a first constant current source connected between the wires of the line in parallel with the terminating impedance, the condition of the constant current source also being controlled in accordance with line conditions under control of said control means, a ringing current supply connection to the voltage source and so arranged that when ringing is to be applied the direct voltage from the voltage source is modulated by the alternating ringing current, a second constant current source connected between the two line wires on the line side of the voltage source which second source is normally disabled but is switched on in the presence of ringing current from the voltage source is limited to a preset value, and further control means associated with the voltage source which limits the alternating ringing current which can flow to a preset limit.

Embodiments of the invention will now be described with reference to Figs. 2 and 3 of the drawing, Fig. 2 being a highly schematic representation of a line circuit embodying the invention, and Fig. 3 a somewhat more detailed, representation of a line circuit embodying the invention.

To activate the magneto bell of a telephone subscriber's instrument we need an alternating current of 60 volts r.m.s., with a current of 20mA (assuming a 3k load), and at a frequency of 2 Hz.

Referring to Fig. 2, it will be seen that the main difference from the circuit of Fig. 1 is the inclusion of an additional constant current device RS, which is referred to as the ringing shunt. The ringing current when needed is applied to the source VVS over a connection RC.

When the line connected to the line circuits is on-hook, the output voltage from the source VVS is controlled to a maximum value of —50 volts, the ringing shunt RS is disabled, and the current regulator PCR is set to permit a current of up to 5mA to flow, dependent on line leakage and on-hook battery charging arrangements (if any).

On receipt of the ring command from the exchange control equipment, the line circuit assumes the ringing mode, in which the current regulator PCR is switched on hard over a connection thereto (not shown) to saturate it by setting it to a condition in which it can deliver a current of 80mA. However, the circuitry, and in particular the circuitry which controls PCR and VVS in dependence on line conditions, does not in fact permit such a high current to flow. In addition, the ringing shunt RS, which is also a constant current source, is also turned on, and this, due to the current it diverts allows a constant current flow from VVS via PCR of 28 mA DC. The connection over which RS is turned on in response to the ring command is also not shown.

The response to the ring command also causes a low level 25 Hz control signal to be connected via a lead RC to the control circuitry associated with VVS, such that the latter generates a 60 volt r.m.s. signal with an 85 volt DC bias. Thus VVS in this cases acts as a ringing current amplifier. The control circuitry for VVS is so arranged that a maximum ringing alternating current of 20mA rms. can flow, regardless of the load connected, i.e. regardless of the line loop parameters. This enables a sinusoidal ringing current flow into the

loop to be maintained under all anticipated loop load conditions. In most respects the control circuitry referred to follows the principle set out in our above-mentioned Patent Specification.

Thus in the ringing mode the A wire of the line remains close to ground potential, while the B wire remains negative, but its potential varies with the defined ringing signal from approximately −1 volt on the positive peak of the ringing signal to approximately −170 volts on the negative peak. Hence the line polarity is not reversed during ringing. The fact that both A and B wires are always negative to earth avoids problems due to galvanic corrosion in the subscriber's line plant.

The magneto bell in the subscriber's instrument is connected to line via a series capacitor, so that apart from a small line leakage the current flowing in the line is AC. With the ringing shunt RS set to 28 mA DC, as mentioned above, an alternating current of up to 20mA can flow in the line. This AC flows through both VVS and PCR, but because of the current regulating action of the ringing shunt RS, no AC can flow through that shunt RS.

During the silent periods of the ringing cadence, the ring command is not effective, so the line circuit reverts to the idle state.

During the silent periods of the ringing cadence, the off hook state is detected by the normal loop sensing arrangements (not shown), which has a threshold of approximately 8mA. That is, if the DC in the loop exceeds 8mA in the silent periods, the loop sensing arrangements assume that the line has gone off hook, and thus removes the ring command and completes the extension of the call to the wanted line.

During the active period of the ringing, the ring trip condition is detected by monitoring the direct voltage across the inherent resistance R of PCR, which has a value of about 10 ohms. The voltage across it corresponds to the line current, plus the 28mA current taken by the ringing shunt RS. This monitoring is done by an operational amplifier OAI; and the effect of the sinusoidal ringing current is eliminated by a low pass filter LPF, so that the output of the filter is a voltage whose value corresponds to that of the direct current in R. This voltage is applied to one input of a comparator COMP, whose other input is a reference voltage V_R the value of which corresponds to the above-mentioned threshold current of 8mA. Hence when the subscriber answers during an active period of the ringing, the additional loop DC through R covers the ring trip detection from the signal at the output of LPF.

We now refer to Fig. 3, in which the ring trip arrangements are not shown, but which shows the control configuration of VVS when the ringing signal is being generated. In this circuit, to save the power dissipation which occurs in the previously-described ringing shunt carrying only DC, the ringing shunt is modulated in push-pull with the ringing signal applied to VVS. The ringing shunt RS, like PCR, uses a transistor whose emitter-collector path is in series with a resistor between the A and B wires, the ringing current being applied to the base of the transistor.

To control the current level and the DC bias of VVS, there is a variable attenuator VA which is fed from the low level ringing source. The attenuator output is compared by a comparator COMPA with the signal monitored from the output of VVS by an error amplifier in the block M connected across the VVS. The output of COMPA controls, as can be seen, both the voltage waveform produced at the output of VVs and the current waveform supplied to the ringing shunt RS. Error signals developed from the peaks of this current waveform cause the stepping of an up-down counter C via the connections shown, the counter outputs in turn controlling the setting of the attenuator. Thus the output current from VVS is limited to a maximum of 20mA, or the output available from VVS is limited to a maximum of 60 volts r.m.s., whichever results in the lower power consumption.

The counter is controlled from the Count-up and Count-down leads, which are in turn controlled from the line. Thus the voltage across ZT is applied via an operational amplifier OA1 to the two comparators COMP 1 and COMP 2 where it is compared with two reference voltages. Thus as the voltage across ZT varies, the counter is stepped up or down to vary the attenuator, and hence the ringing signal amplitude.

CLAIMS:

1. A telephone subscriber's line circuit, which includes a terminating impedance connected between the two wires of the line, which impedance has a centre-tap which is earthed, a variable voltage source supplied by the exchange power supply and whose output provides the direct current voltage drive for the line, control means which monitors the direct voltage between the line wires and to so control the voltage source that the voltage supplied therefrom is controlled in accordance with line conditions, such that variations in line conditions cause compensatory variations in the line voltage supply, a first constant current source connected between the wires of the line in parallel with the terminating impedance, the condition of the constant current source also being controlled in accordance with line conditions under control of said control means, a ringing current supply connection to the voltage source and so arranged that when ringing is to be applied the direct voltage from the voltage source is modulated by the alternating ringing current, a second constant current source connected between the two line wires on the line side of the voltage source which second source is normally disabled but is switched on in the presence of ringing current from the voltage source is limited to a preset value, and further control means associated with the voltage source which limits the alternating ringing current which can flow to a preset limit.

2. A line circuit as claimed in claim 1, and in which the second constant current source includes a transistor whose emitter-collector path is connected in series with a resistor between the

two wires, control being exerted thereon by the application of control conditions to the base of the transistor.

3. A line circuit as claimed in claim 2, and in which ringing current is applied in antiphase to the base of said transistor, such that the net waveform on the line stays sinusoidal.

4. A telephone subscriber's line circuit, substantially as described with reference to Fig. 2 or Fig. 3 of the accompanying drawing.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1983. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.